Apportionment of Ambient PM_{10} Crustal Component Using SEM Data -Corcoran Fall 2000 Study-

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CRPAQS Workshop
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SEM/CCSEM Analysis

- Analytical techniques that provide information on size, morphology and elemental composition on individual particles.
  - SEM: Scanning Electron Microscopy
  - CCSEM: Computer Controlled Scanning Electron Microscopy

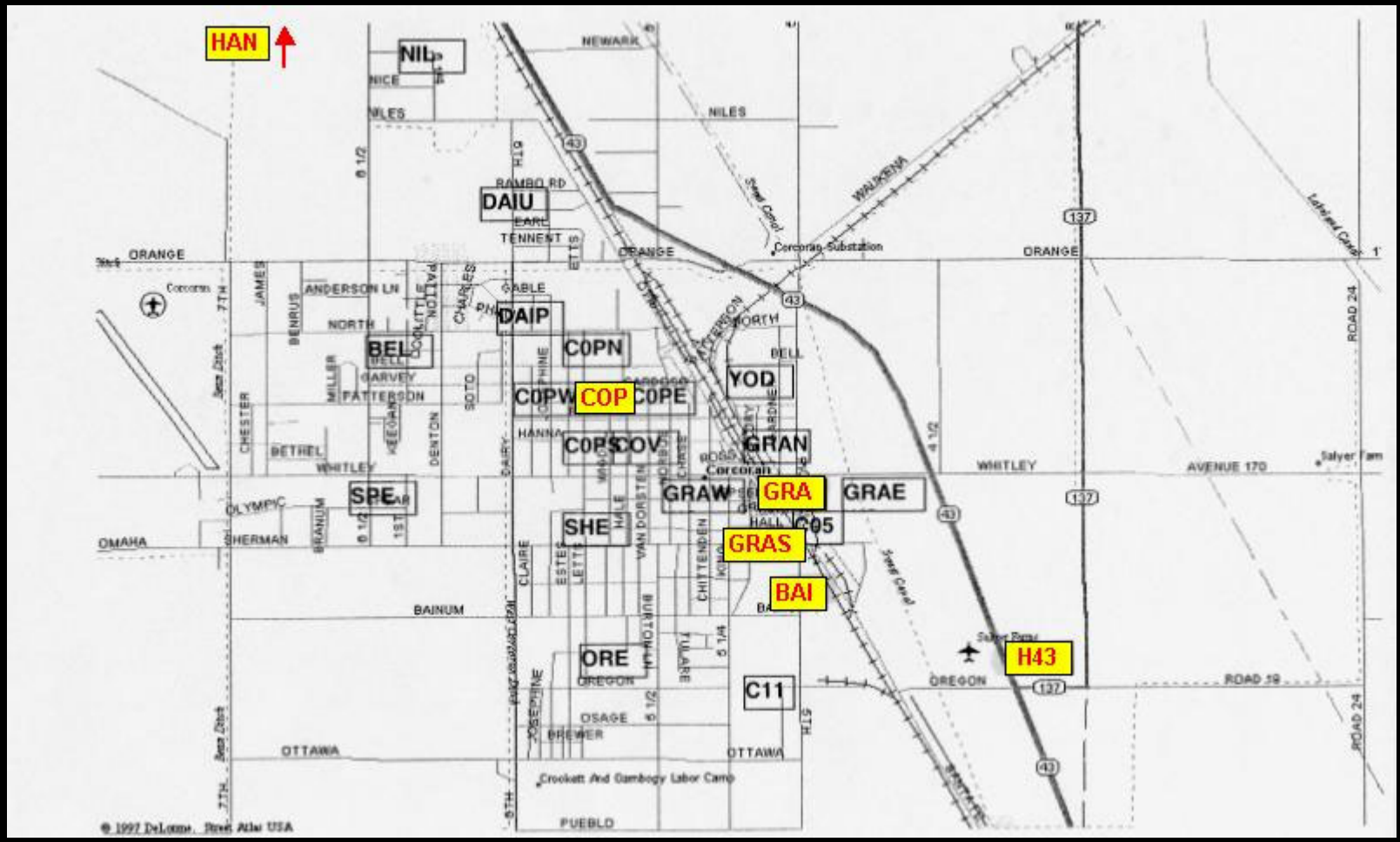
Corcoran Fall 2000 Study

- Determine the impact of crustal sources of PM_{10} at six ambient monitoring sites in Corcoran using SEM and CCSEM techniques.
- Assess the extent of contributions from urban and regional sources.
- Conclusions directed toward supporting PM_{10} emissions reduction plans in the State Implementation Plan (SIP).

Sampling Locations

- Samples collected at 6 locations.
  - COP: Corcoran core site
  - GRA: Grain Elevators
  - GRAS: 200 m South of GRA site
  - BAI: Cotton handling area
  - H43: Highway near airport
  - HAN: Hanford (background location)

Map of Corcoran Ambient Sites

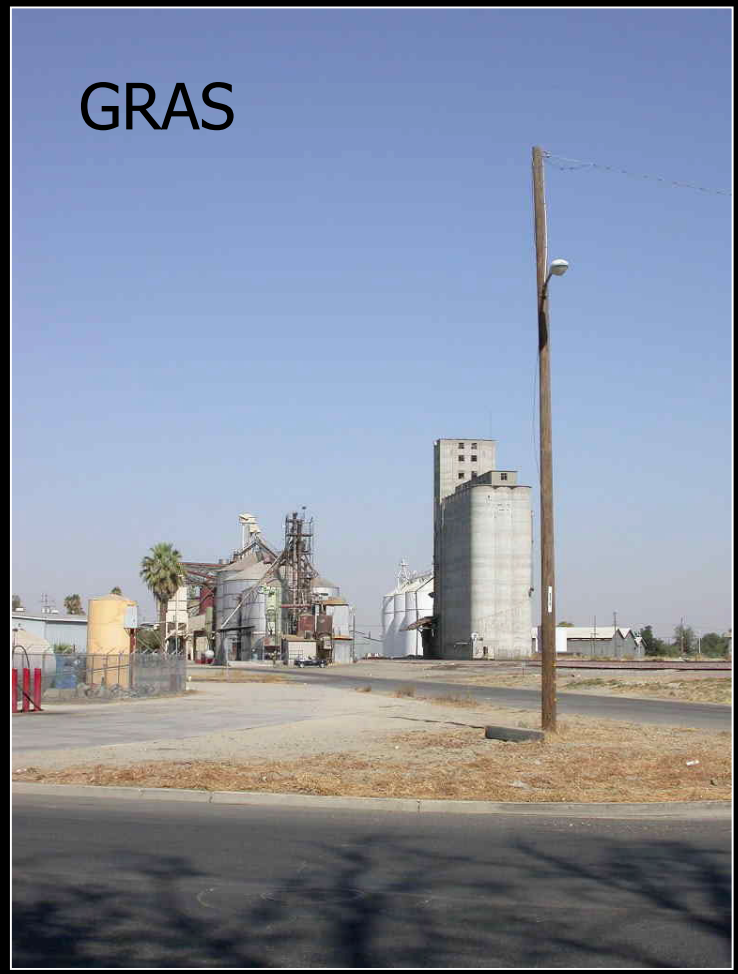


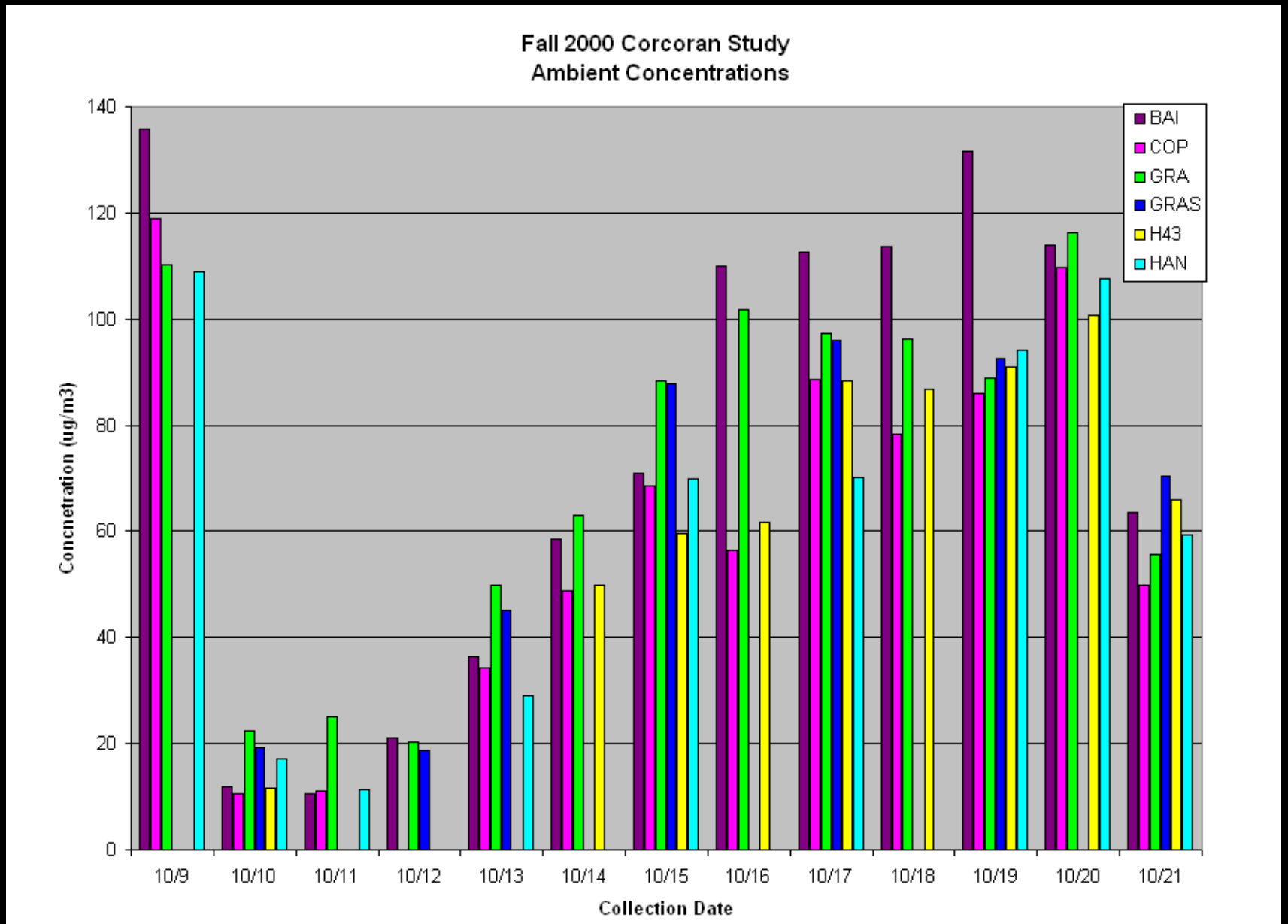
BAI Sampling Site

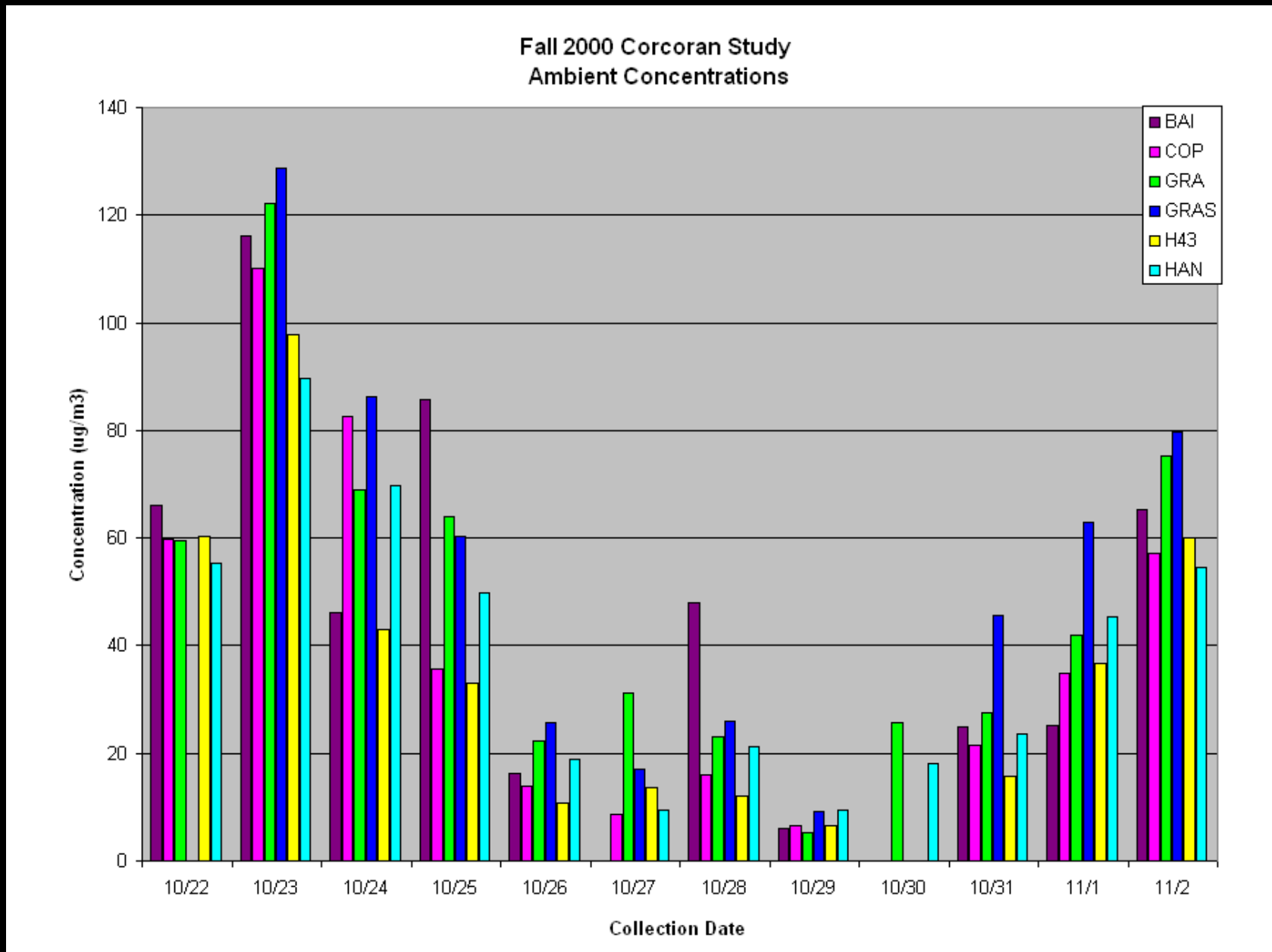
COP Sampling Site

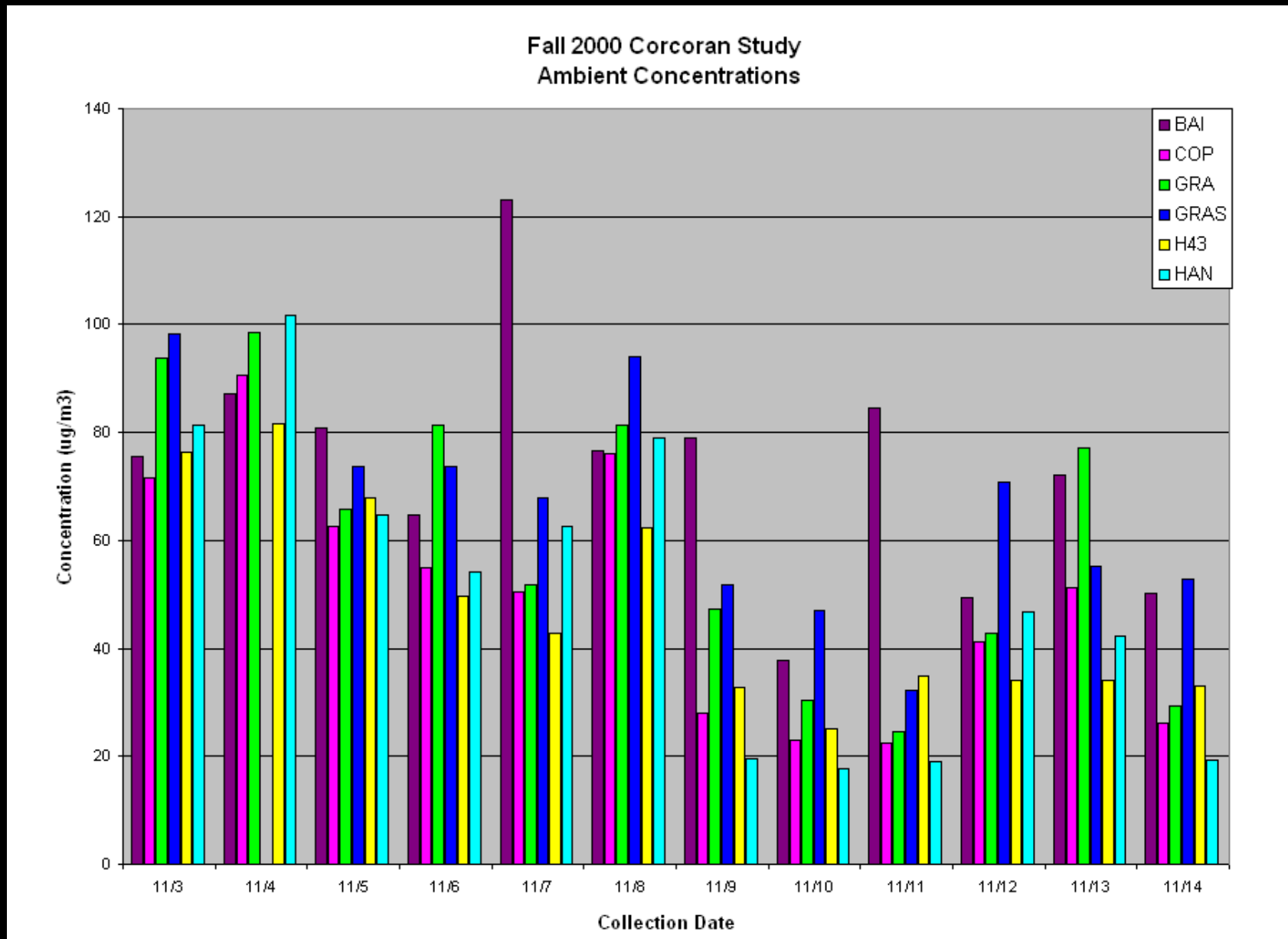
GRA Sampling Site

Corcoran Sampling Site




Fall 2000 Corcoran Study
Ambient Concentrations
Concnetration (ug/m3)
140
120
100
80
60
40
20
0
10/9
10/10
10/11
10/12
10/13
10/14
10/15
10/16
10/17
10/18
10/19
10/20
10/21
Collection Date
BAI
COP
GRA
GRAS
H43
HAN


Fall 2000 Corcoran Study
Ambient Concentrations
Concentration (ug/m3)
140
120
100
80
60
40
20
0
BAI
COP
GRA
GRAS
H43
HAN
10/22
10/23
10/24
10/25
10/26
10/27
10/28
10/29
10/30
10/31
11/1
11/2
Collection Date

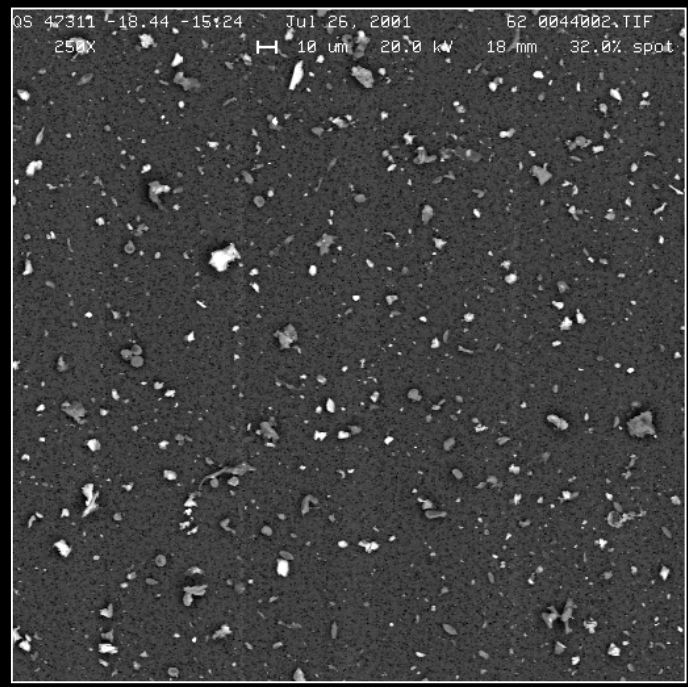

Fall 2000 Corcoran Study
Ambient Concentrations
Concentration (ug/m3)
0
20
40
60
80
100
120
140
11/3
11/4
11/5
11/6
11/7
11/8
11/9
11/10
11/11
11/12
11/13
11/14
Collection Date
BAI
COP
GRA
GRAS
H43
HAN

Project Methodology

- "Bulk" soil (source) samples collected near each ambient monitor.
- PM_{10} samples collected on 37 mm PC filters over 24 hour period using "minivol" samplers operating at 5 l/min.
- Section of as-collected filter place on SEM stub.
- Examined and analyzed using SEM and CCSEM techniques.

Minivol Sampler: 5 l/min

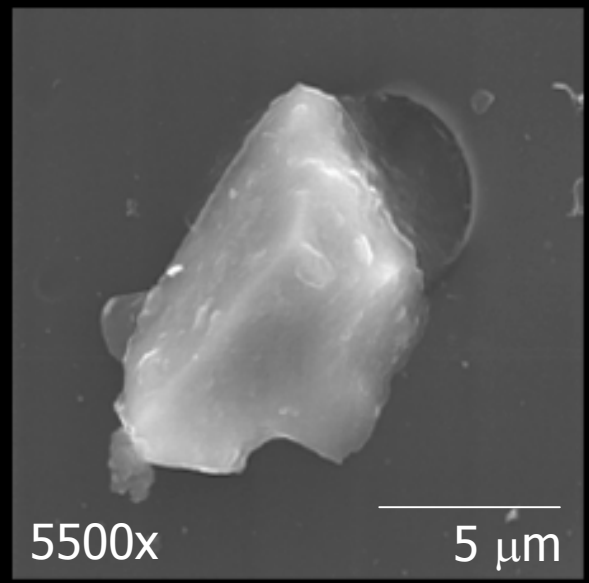
Polycarbonate Filter

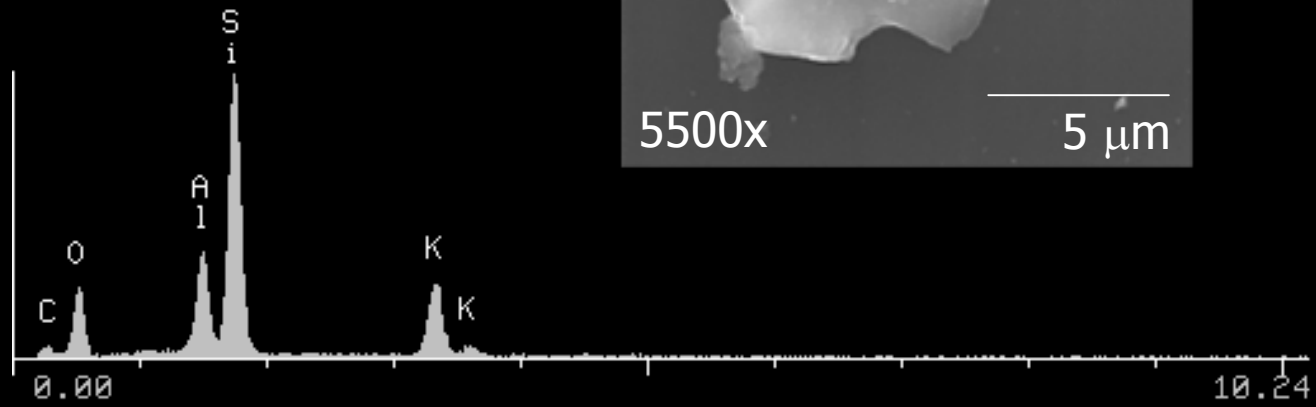


Example of SEM Data

Size, Shape/Morphology
Elemental composition
- Association
- Identification

- Peak location related to element
- Peak area related to abundance





SEM/CCSEM Analysis Protocol

- Select Days for Analysis
- Initial SEM Examination
  - Manual SEM screening
- CCSEM Analysis/Data Review
- Detailed Manual SEM Analysis
- Final Data Summary

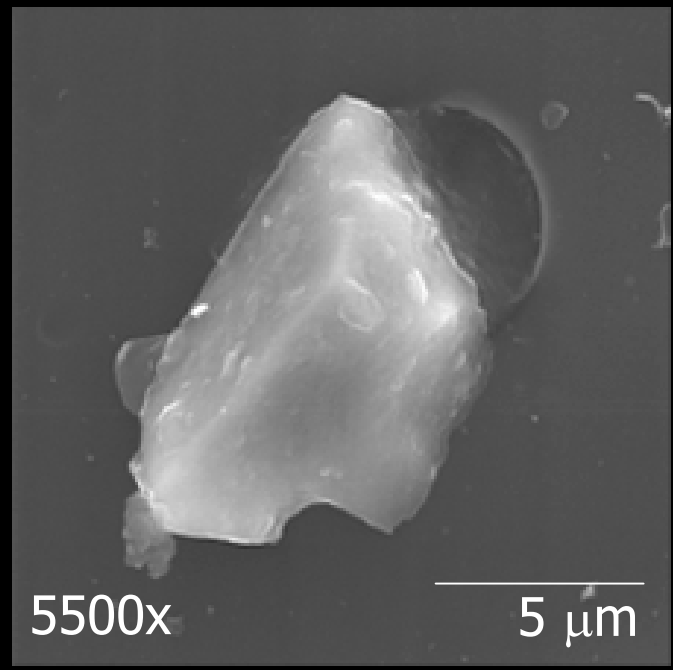
CCSEM Analysis Methodology

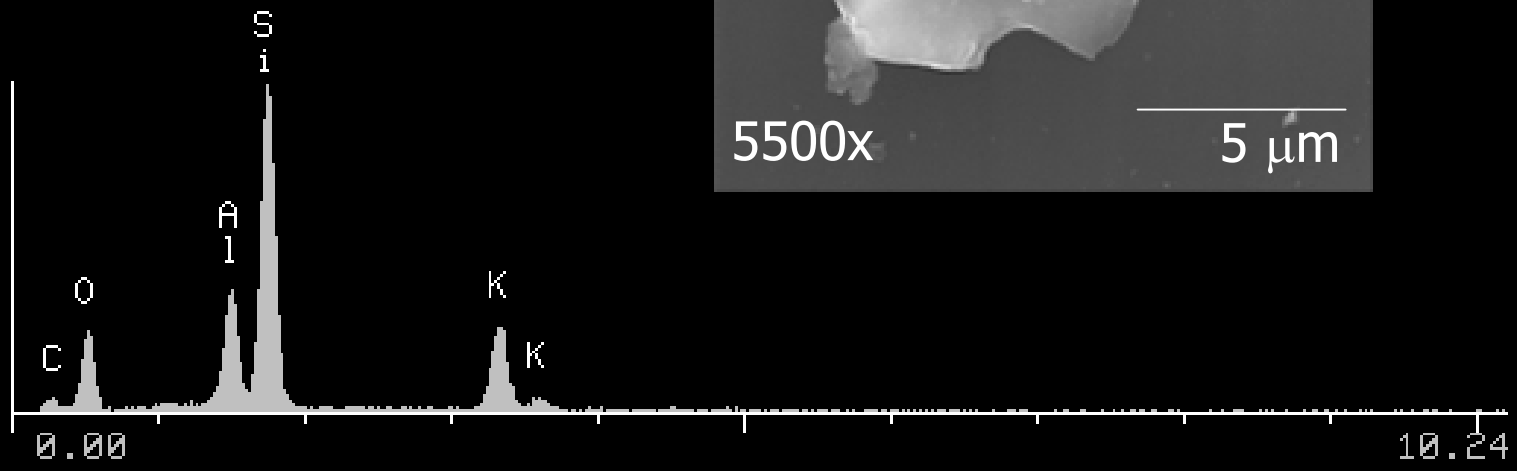
- 2500 particles analyzed per sample.
  - Focus analysis on crustal particles >1μm.
  - Digital images acquired for each particle.
- Particles sorted into classes (particle types) based on individual particle data.
    - Elemental composition + (shape)
- Frequency/mass distributions determined for each class and for total sample.

Particle Type Classification

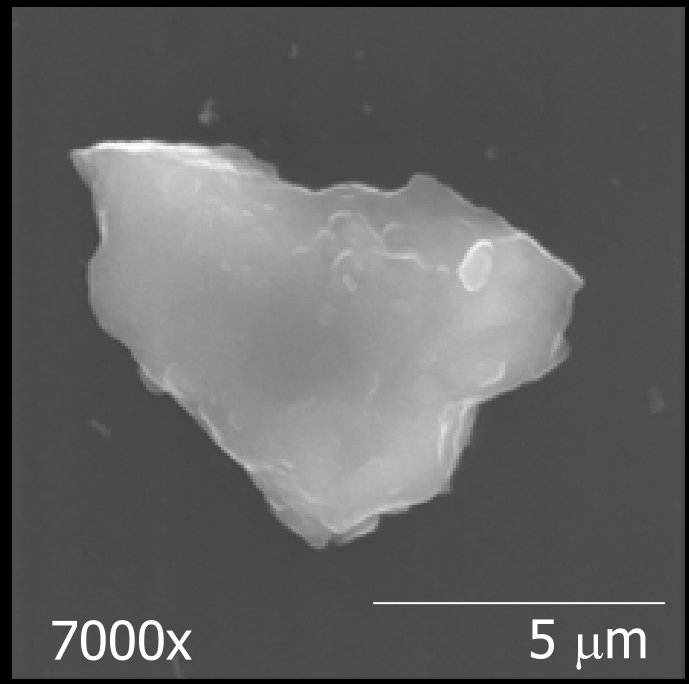
- Individual particles were classified into one of 25 specific particle type classes based on elemental composition.
- The samples were comprised primarily of earth crustal material rich in silicon and aluminum often containing sodium, magnesium, potassium, calcium and iron either singularly or in combination.

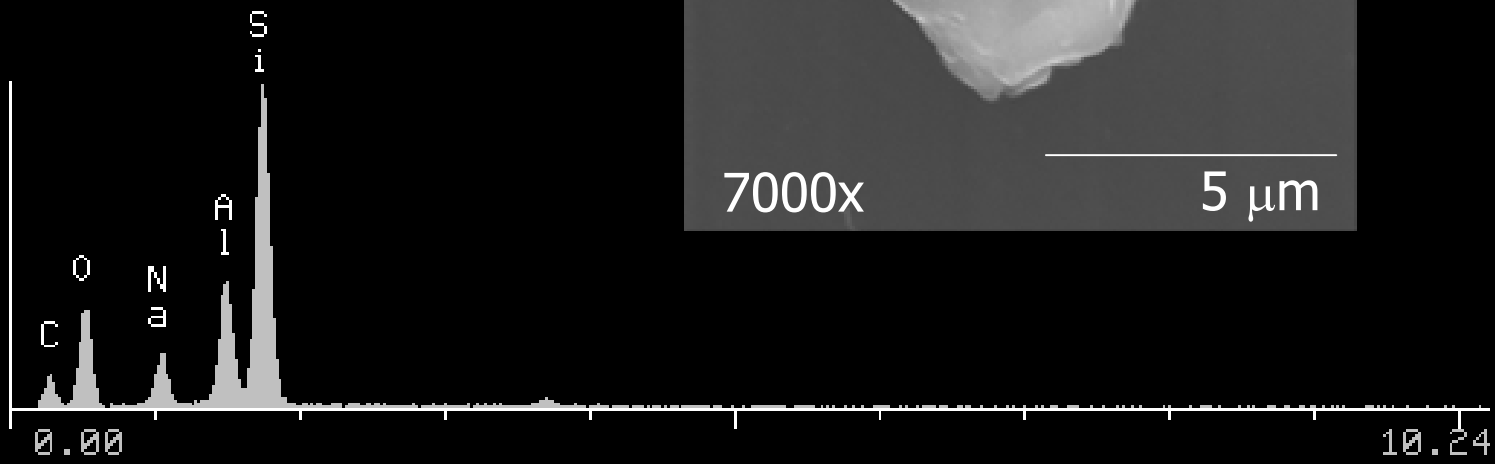
Si/Al/K-rich





Si/Al/Na-rich

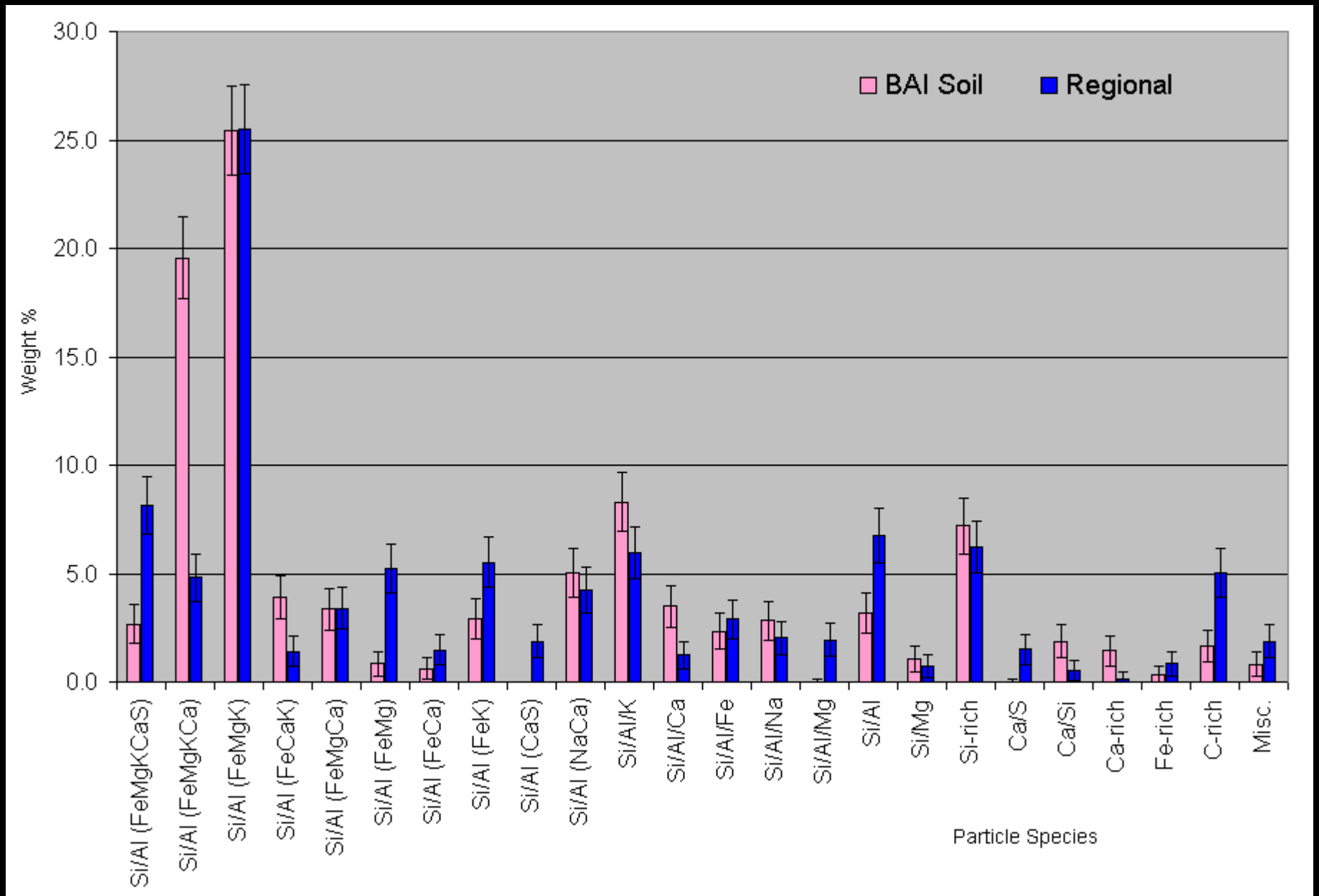




Source Apportionment of Corcoran PM_{10} Samples Using the Chemical Mass Balance (CMB) Model

CMB Methodology

- Develop crustal source profiles based on CCSEM analysis of soil samples collected near ambient monitors.
- Ambient samples analyzed using CCSEM.
- Hanford ambient data used as regional background source profile.
- Source and ambient CCSEM data used as input in CMB (version 8) receptor model.


30.0
25.0
20.0
15.0
10.0
5.0
0.0
Weight %
BAI Soil
Regional
Si/Al (FeMgKCaS)
Si/Al (FeMgKCa)
Si/Al (FeMgK)
Si/Al (FeCaK)
Si/Al (FeMgCa)
Si/Al (FeMg)
Si/Al (FeCa)
Si/Al (FeK)
Si/Al (CaS)
Si/Al (NaCa)
Si/Al/K
Si/Al/Ca
Si/Al/Fe
Si/Al/Na
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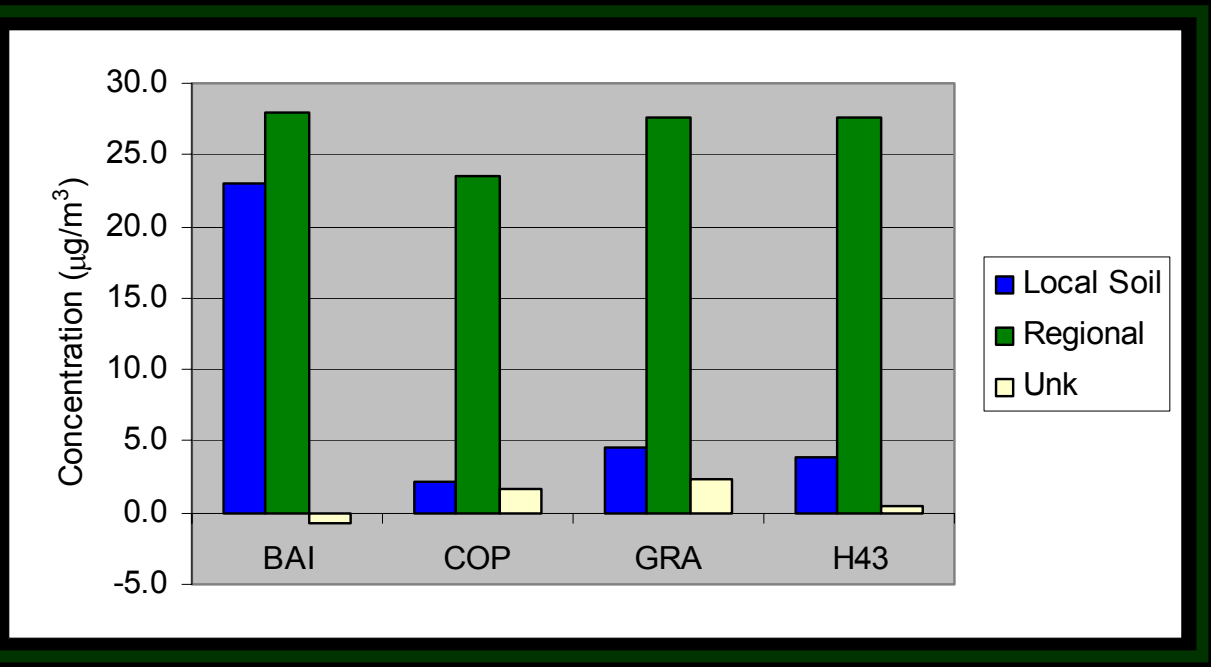
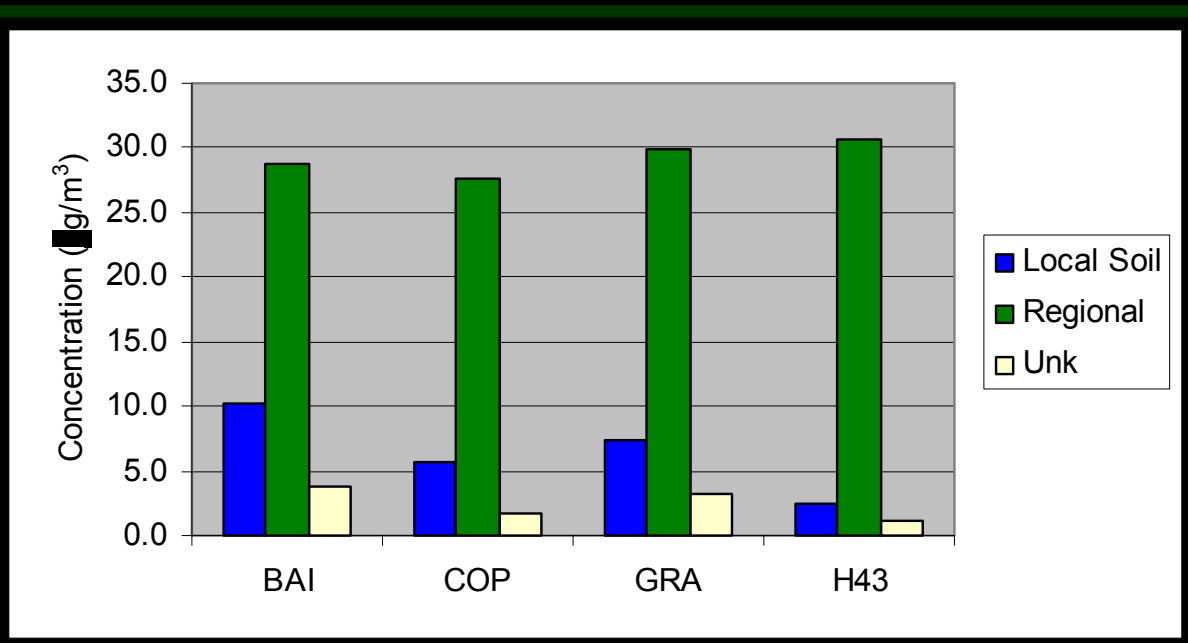
Si/Mg
Si-rich
Ca/S
Ca/Si
Ca-rich
Fe-rich
C-rich
Misc.
Particle Species



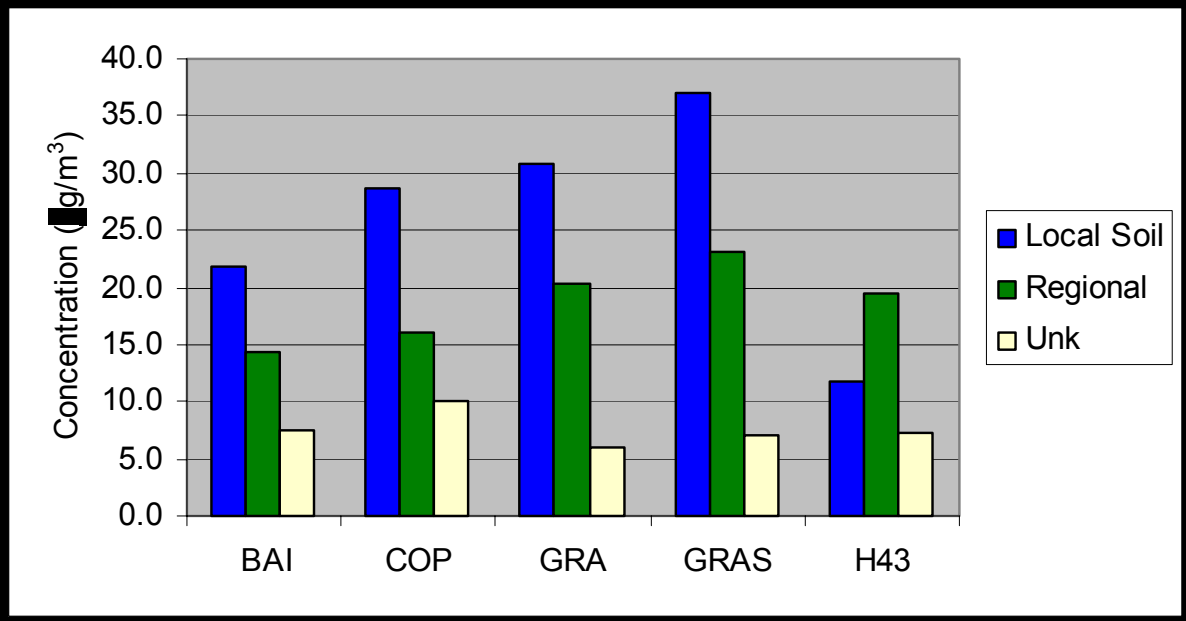
10-18-00 CMB8 Crustal Results

Site	Concentration (µg/m³) Total	Local Soil	Regional	Unk	Percent Local Soil	Regional	Unk	R^2	Chi^2	OC	EC
BAI	50.3	23.0	28.0	-0.7	45.7	55.6	-1.3	0.91	0.96	26.1	2.9
COP	27.4	2.2	23.5	1.6	8.2	85.8	6.0	0.90	0.80	17.9	2.3
GRA	34.5	4.5	27.6	2.4	13.0	80.1	6.9	0.92	0.63	20.9	2.1
GRAS	NA										
H43	32.0	3.8	27.7	0.5	11.9	86.5	1.6	0.90	0.86	21.0	2.8



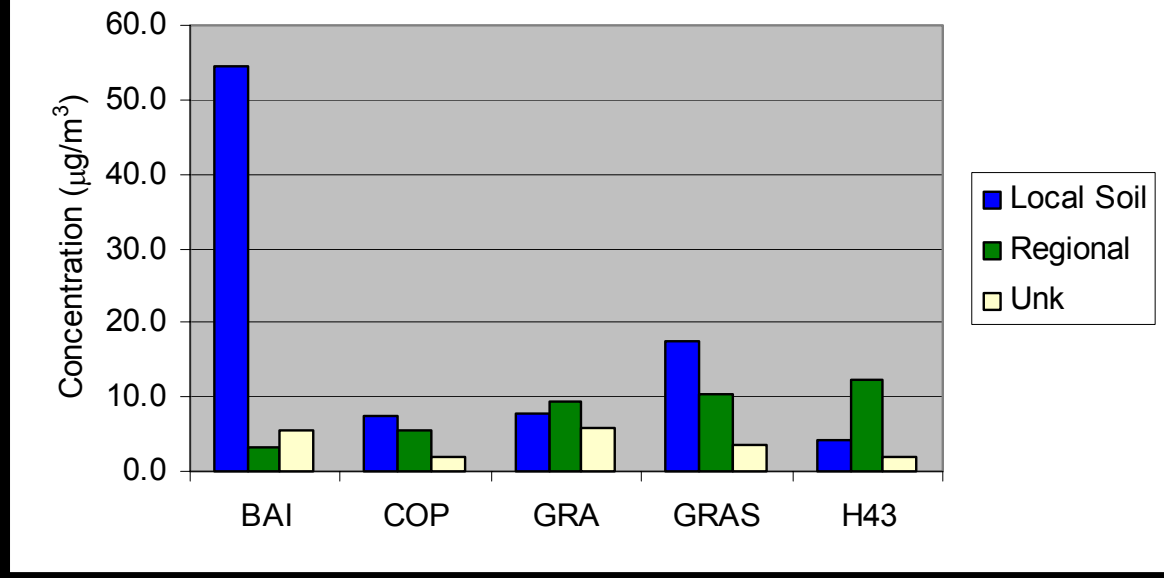
10-20-00 CMB8 Crustal Results

Site	Concentration (µg/m³) Total	Local Soil	Regional	Unk	Percent Local Soil	Regional	Unk	R^2	Chi^2	OC	EC
BAI	42.6	10.1	28.7	3.8	23.8	67.3	8.9	0.88	1.28	20.3	2.2
COP	35.2	5.7	27.7	1.8	16.3	78.7	5.0	0.93	0.64	21.1	2.7
GRA	40.6	7.4	30.0	3.2	18.3	73.8	7.9	0.91	0.81	21.9	3.0
GRAS	NA										
H43	34.3	2.5	30.6	1.2	7.4	89.2	3.4	0.93	0.65	20.4	2.5



10-24-00 CMB8 Crustal Results

Site	Concentration (µg/m³) Total	Local Soil	Regional	Unk	Percent Local Soil	Regional	Unk	R^2	Chi^2	OC	EC
BAI	43.6	21.8	14.3	7.5	50.0	32.7	17.3	0.85	1.71	8.7	1.4
COP	54.8	28.6	16.1	10.1	52.2	29.4	18.4	0.85	1.54	15.6	2.3
GRA	57.1	30.8	20.2	6.1	54.0	35.4	10.6	0.89	1.19	18.0	2.4
GRAS	67.2	37.1	23.1	7.0	55.2	34.4	10.4	0.93	0.69	15.0	1.8
H43	38.8	11.9	19.5	7.4	30.6	50.4	19.0	0.85	1.62	9.8	2.1



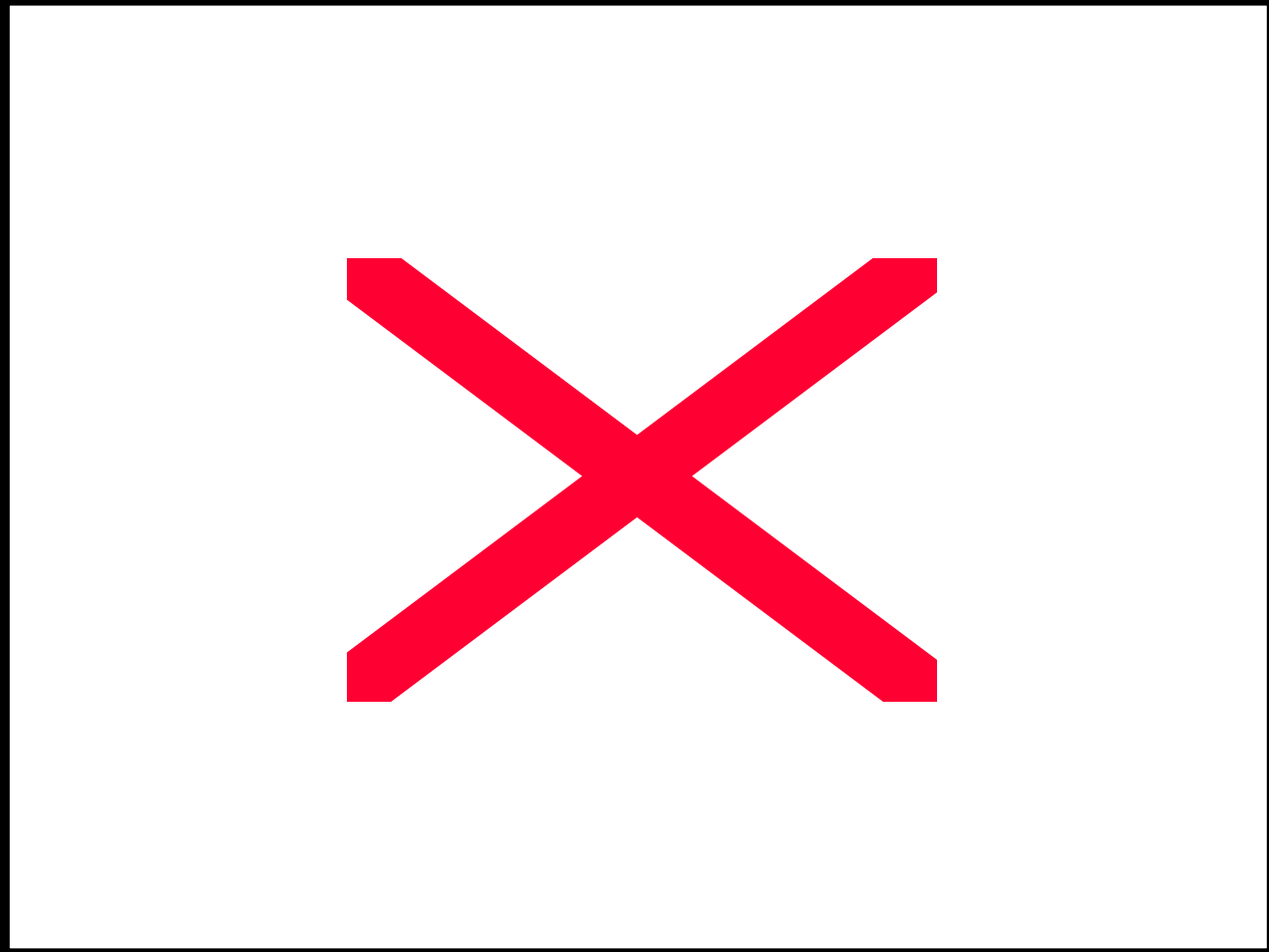
11-9-00 CMB8 Results

Site	Concentration (µg/m³) Total	Local Soil	Regional	Unk	Percent Local Soil	Regional	Unk	R^2	Chi^2	OC	EC
BAI	63.4	54.5	3.2	5.6	86.0	5.1	8.9	0.90	0.88	10.2	1.8
COP	14.8	7.3	5.6	1.9	49.4	37.6	13.0	0.87	1.40	9.9	1.1
GRA	23.1	7.9	9.4	5.8	34.1	40.8	25.1	0.82	1.70	14.8	1.4
GRAS	31.6	17.6	10.5	3.5	55.6	33.2	11.2	0.92	0.81	12.1	1.8
H43	18.3	4.1	12.3	2.0	22.2	66.9	10.9	0.80	2.15	6.6	1.5

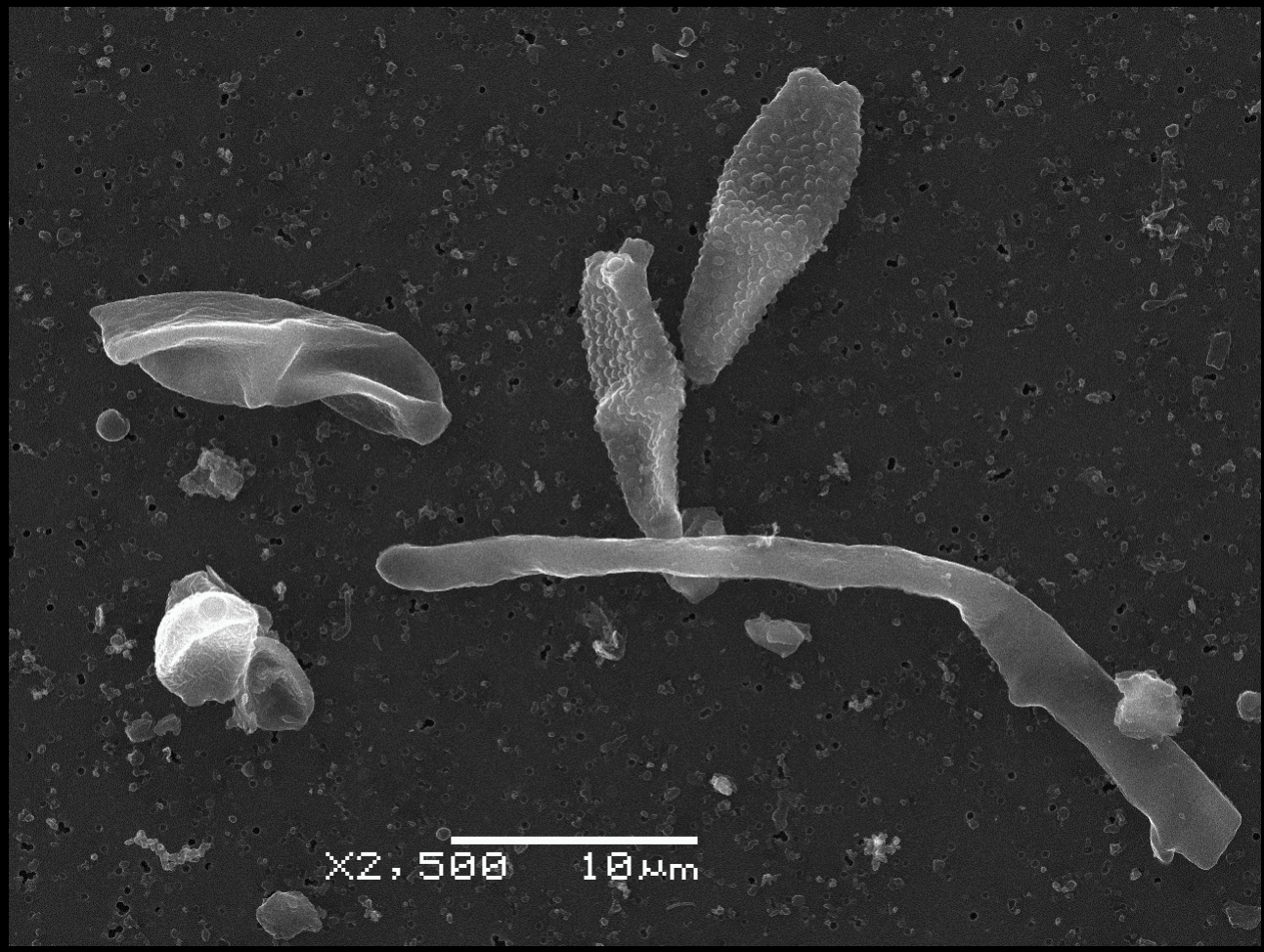
Carbonaceous Particle Characterization

- Manual SEM analysis was performed on each of the fugitive dust samples in an effort to provide insight on the nature of the carbon-rich particulate.
- Carbon-rich particles have the potential to provide additional information which can be used to distinguish among the sources that have similar inorganic elemental composition.

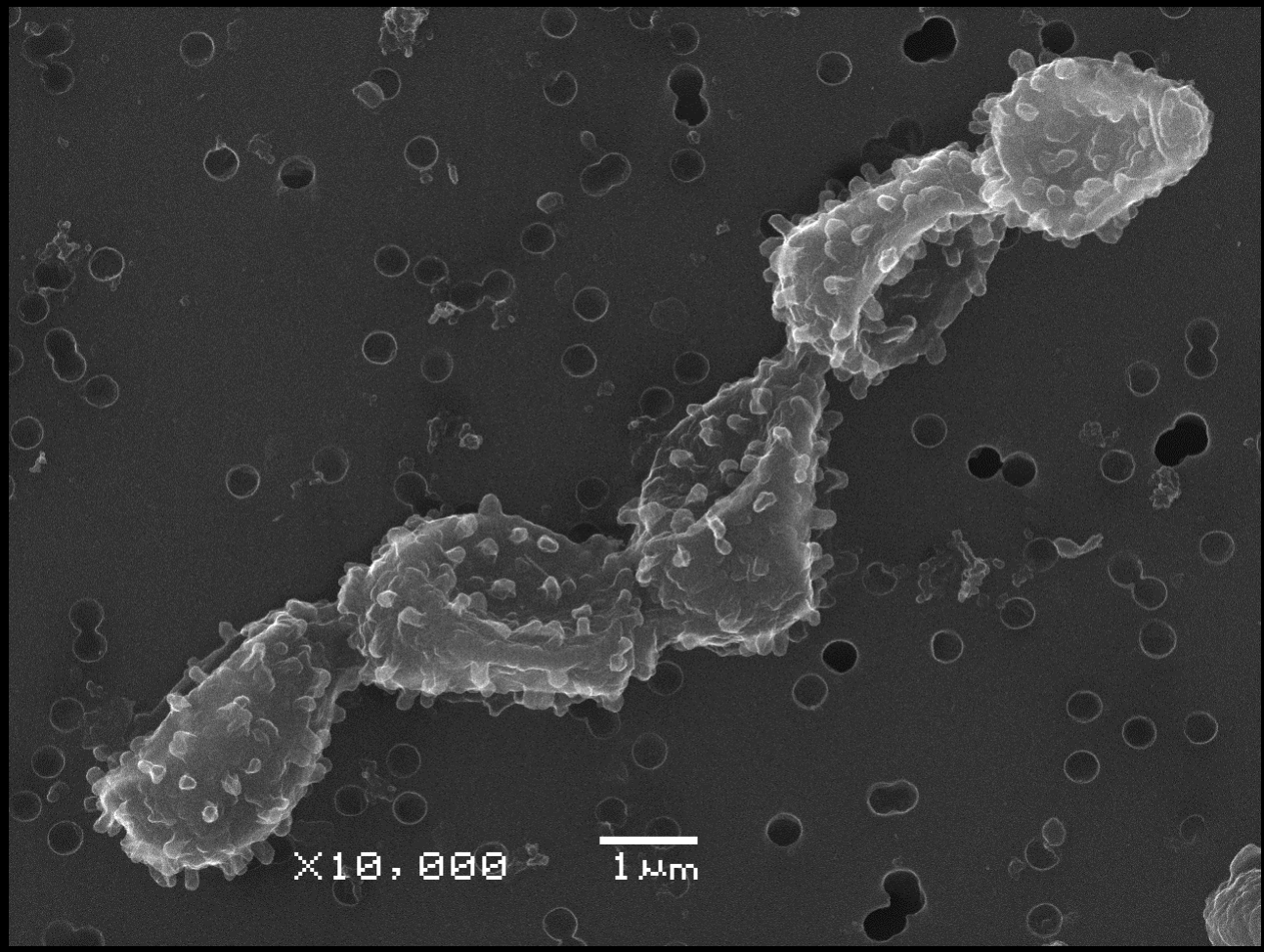
Vegetative Particles
10-14-00 BAI



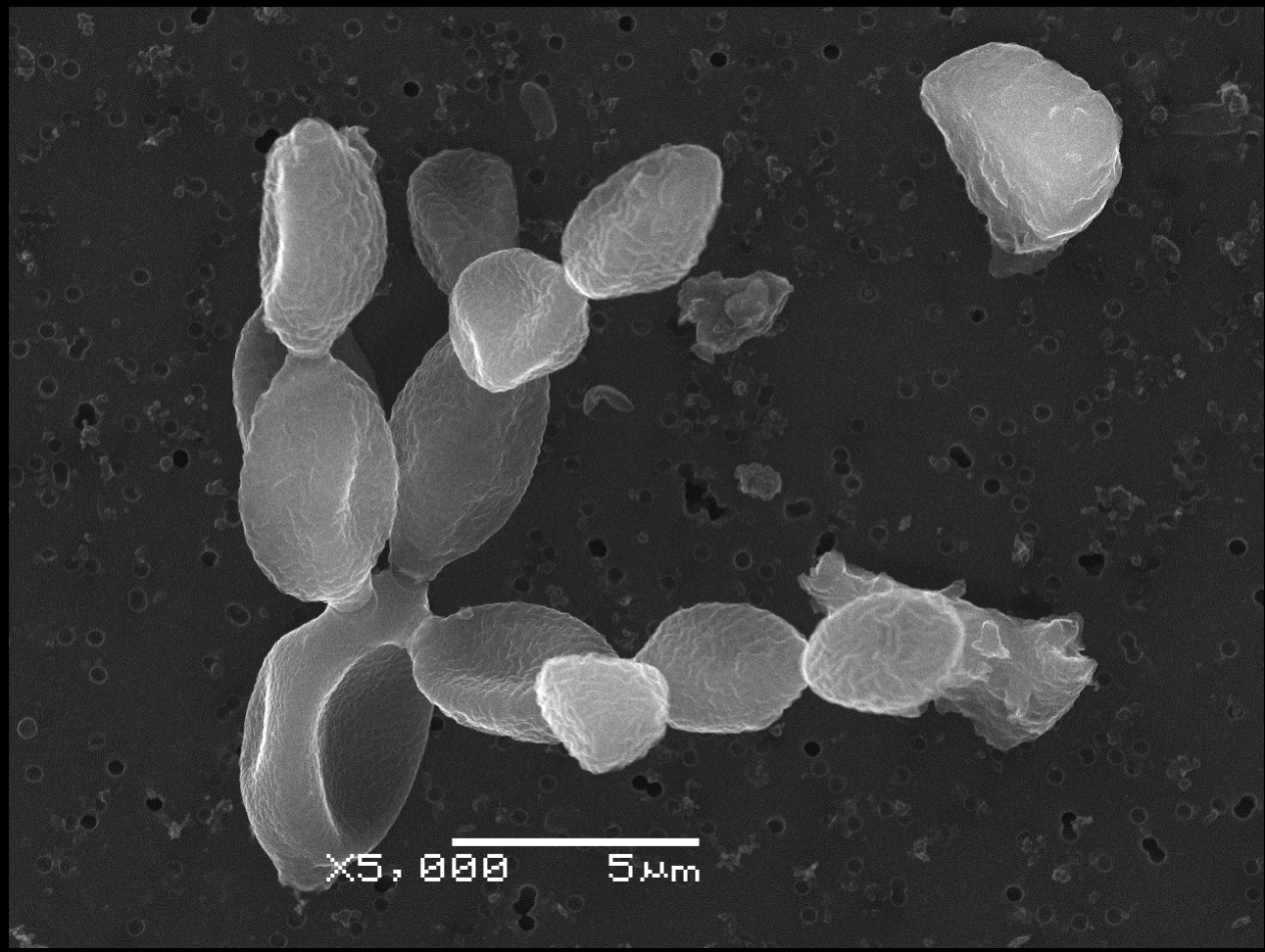
Vegetative Particles
10-14-00 BAI



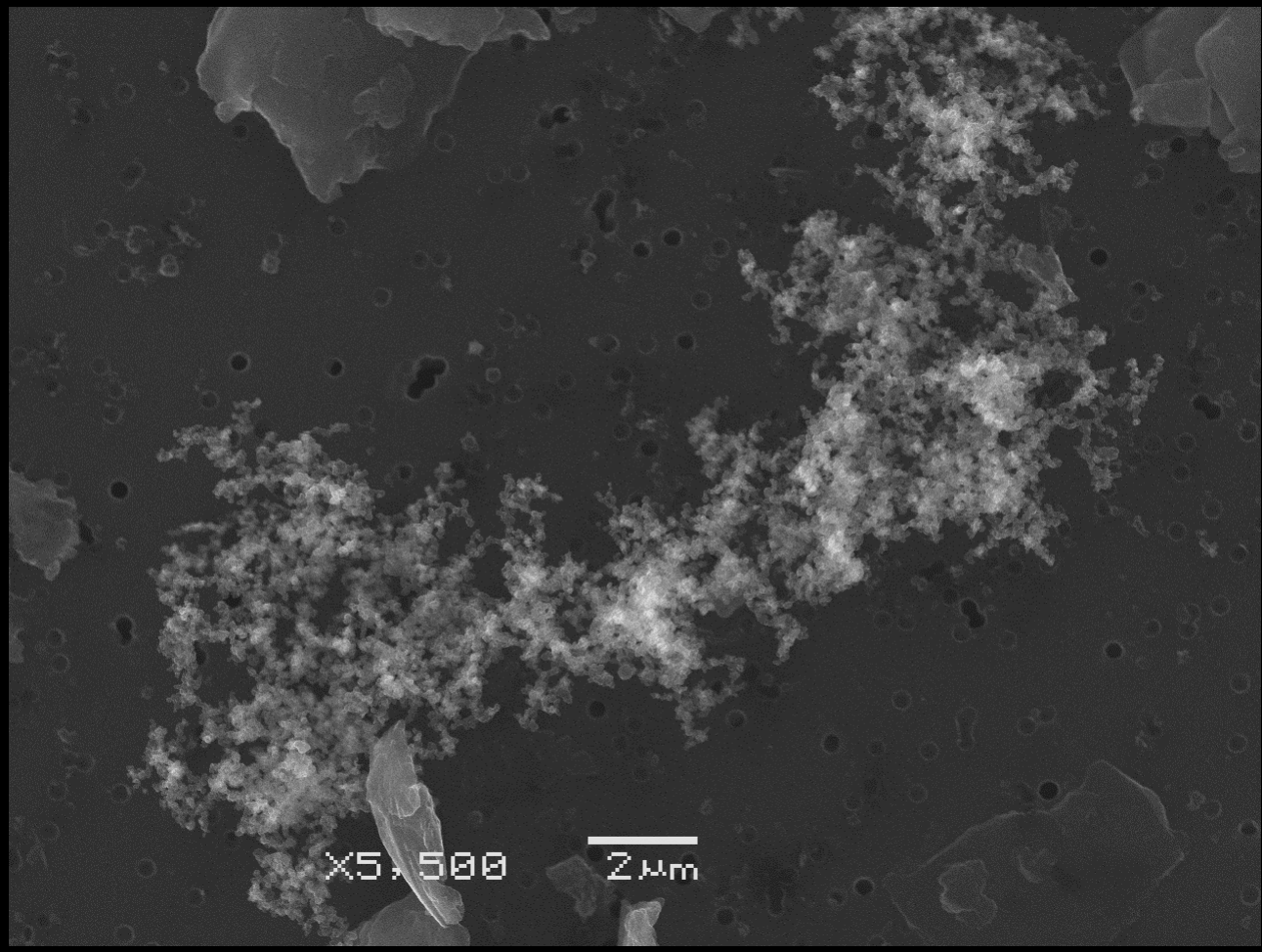
Vegetative Particles
11-9-00 GRA



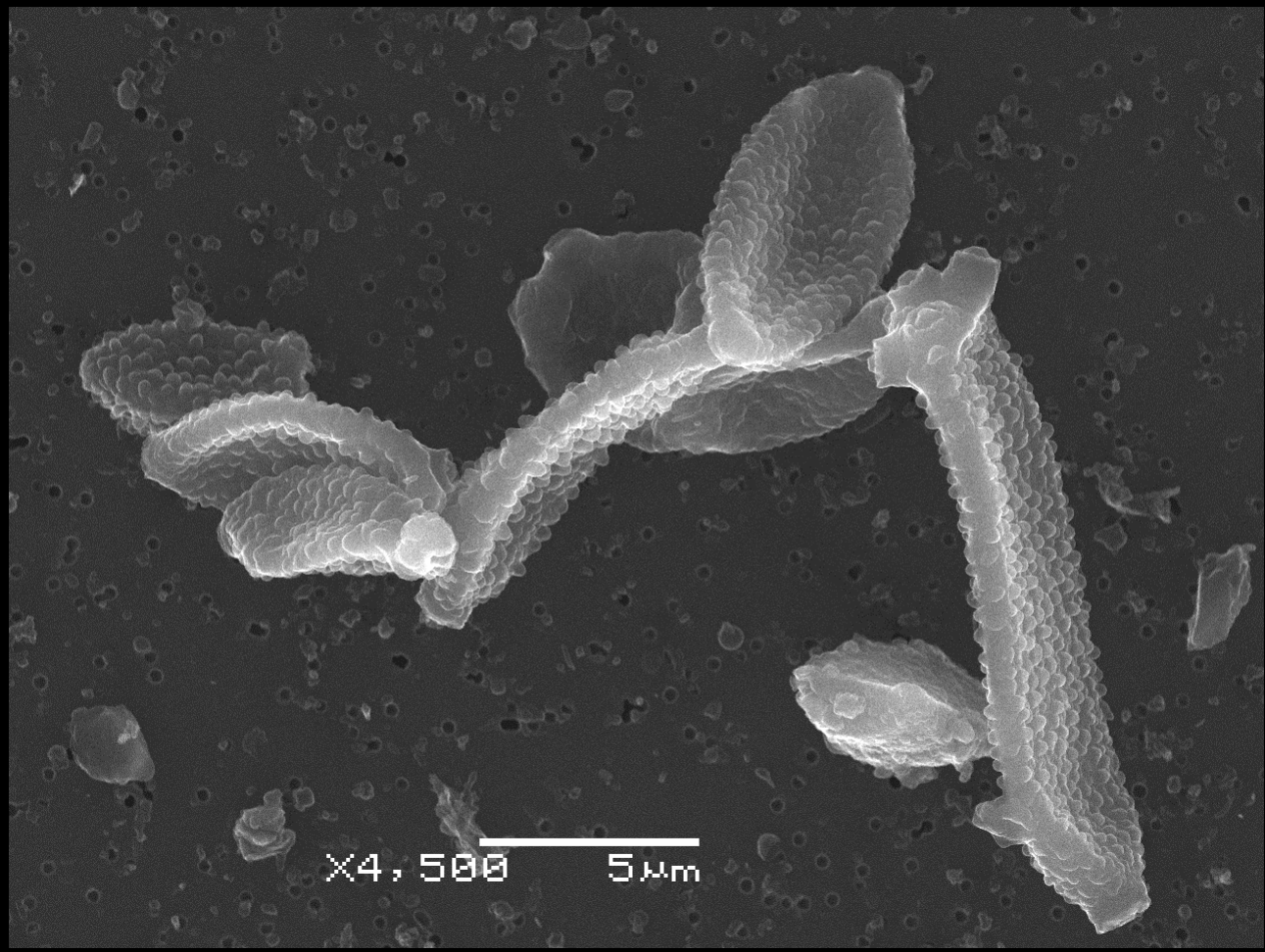
Vegetative Particles
11-9-00 GRA



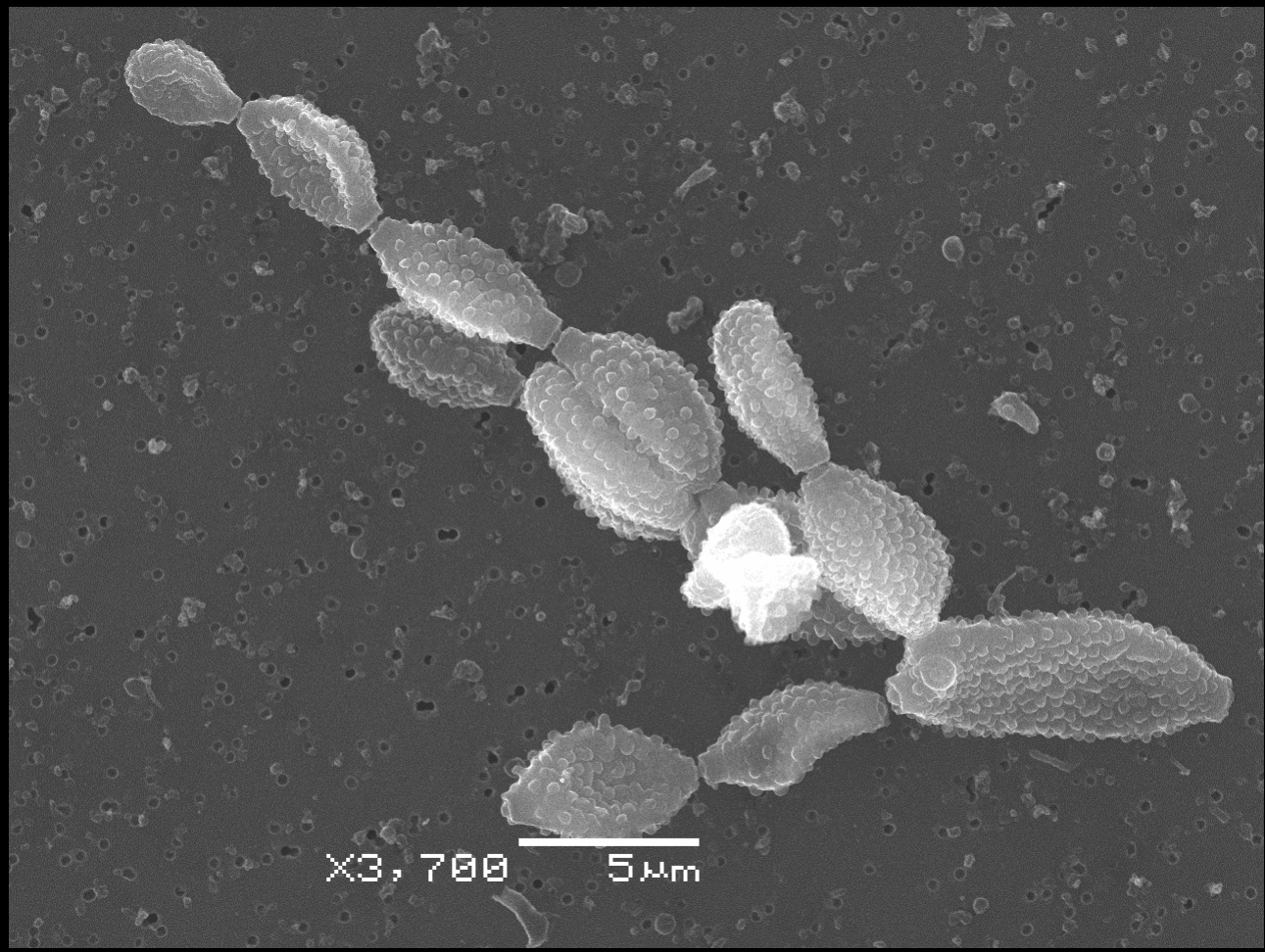
Vehicular Particles
11-9-00 GRA



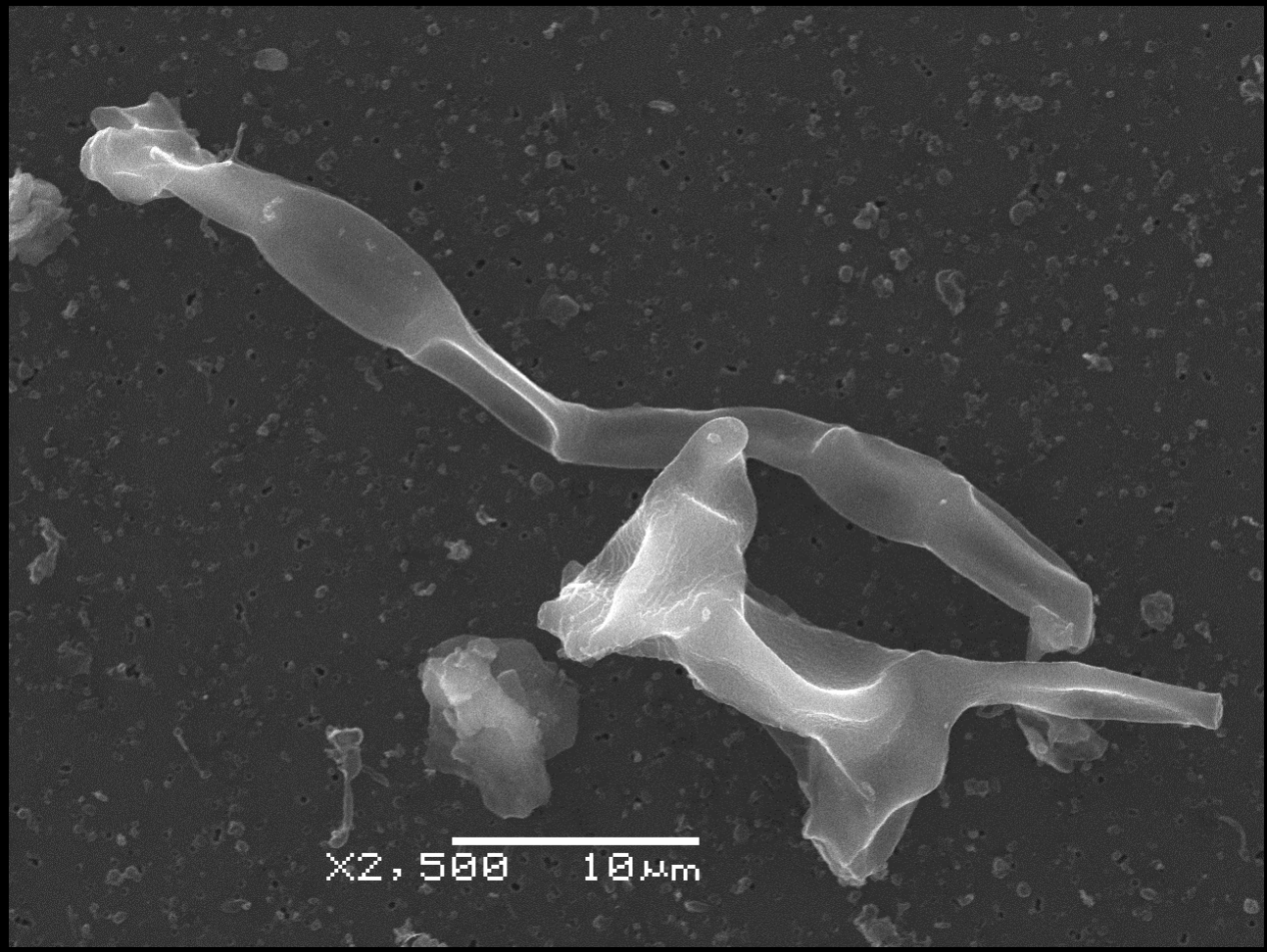
Vegetative Particles
11-11-00 H43



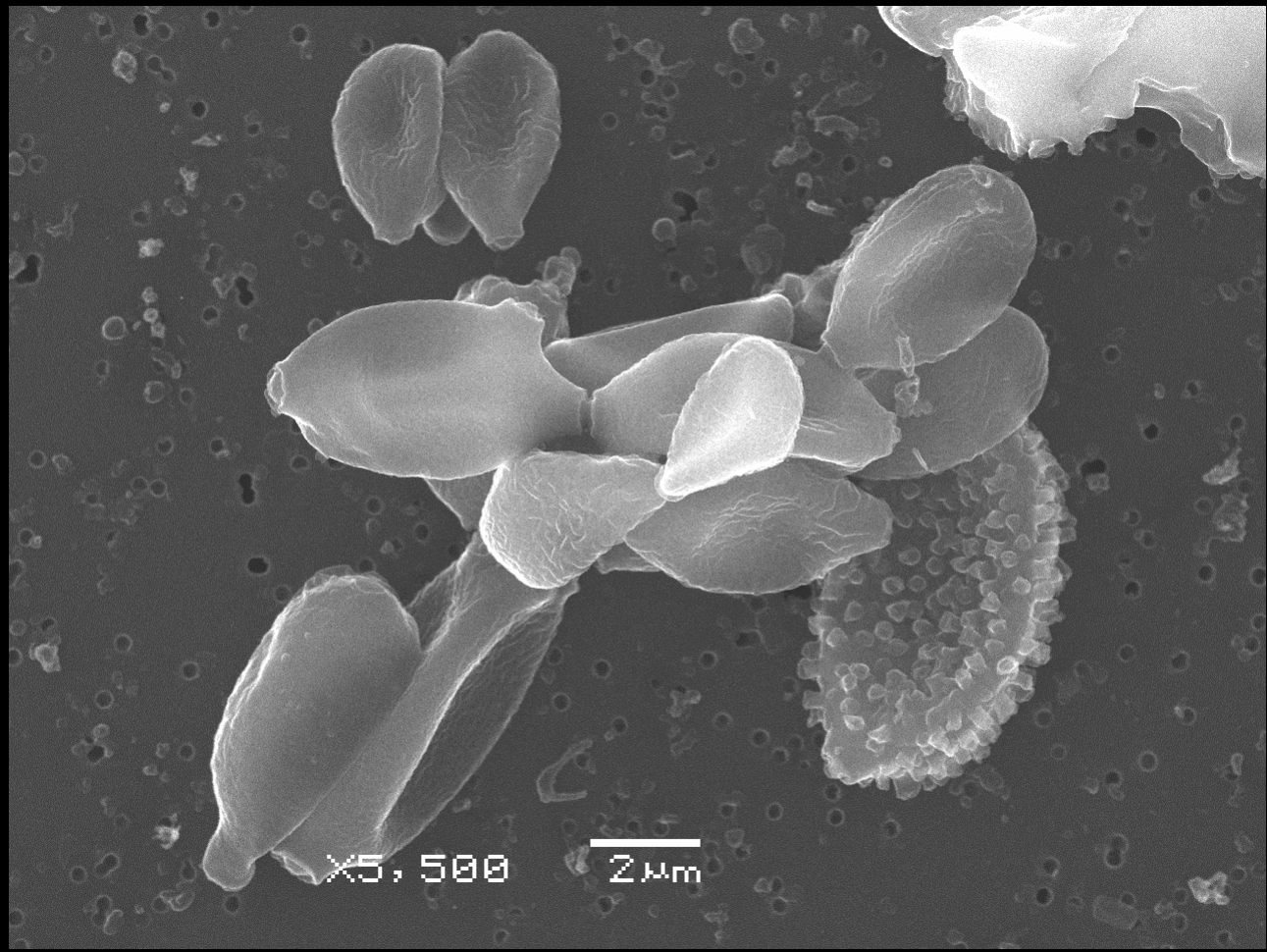
Vegetative Particles
11-11-00 H43



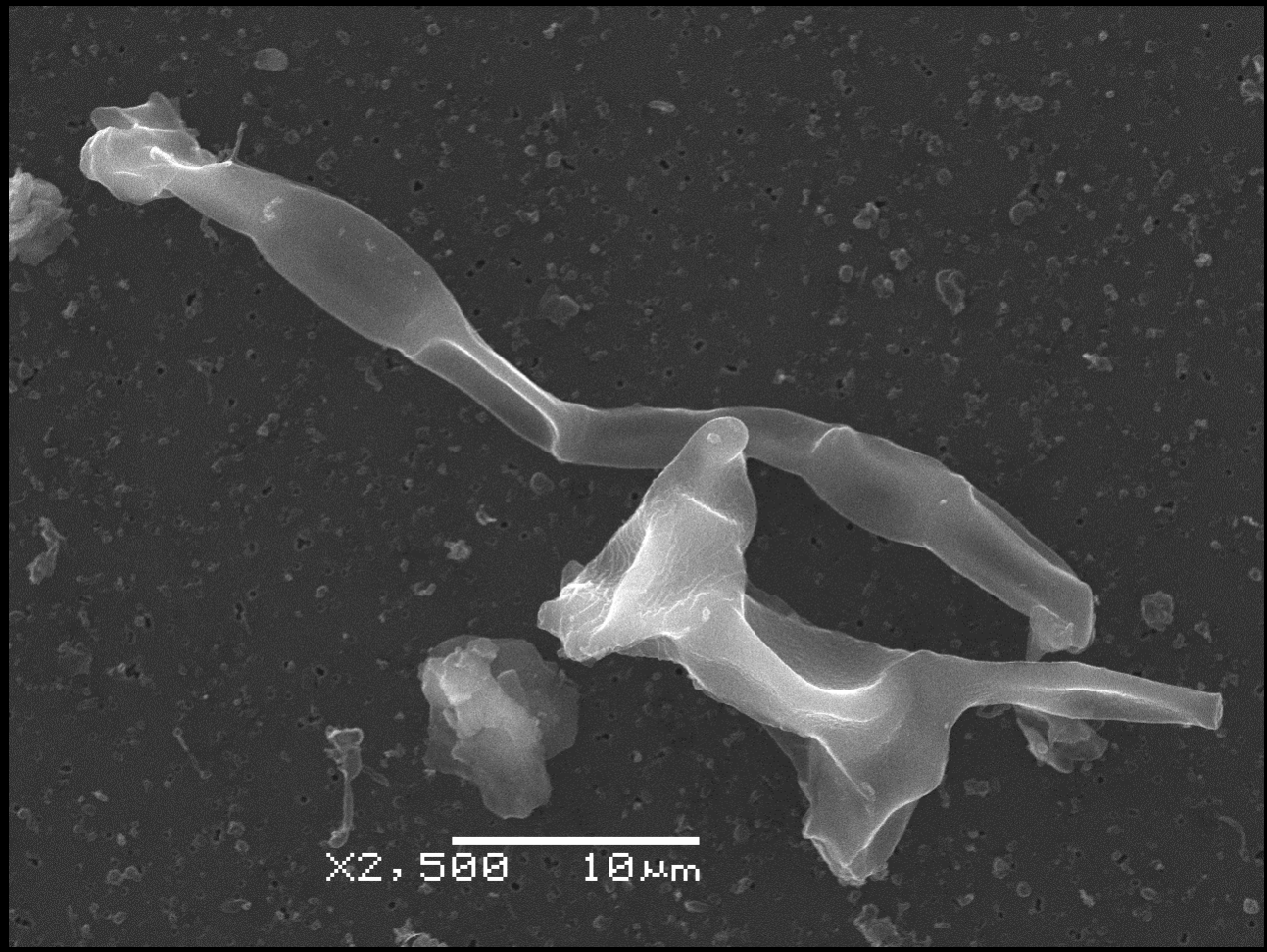
11-11-00 H43



11-11-00 H43



11-11-00 H43



Conclusions

- Minivols provided samples well suited for SEM/CCSEM analysis.
- CCSEM can be used to effectively apportion the crustal component in ambient PM_{10} samples.
- On average, regional background dust was the dominant crustal source at COP, GRA, GRAS and H43.
- BAI site was attributed to local and regional crustal sources nearly equally.
- Organic carbon component appears composed mainly of vegetative material.

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